MULTIMEDIA UNIVERSITY®

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

EMF2016 ELECTROMAGNETIC THEORY

(All Sections / Groups)

22 OCTOBER 2018
9 A.M – 11 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 10 pages including this cover page with 4 questions only. Common constants for air are listed on Page 5.

2. Attempt all four questions. All questions carry equal marks and the distribution of marks for each question is given.

3. Please print all your answers in the answer booklet provided.

4. Please tie and submit worked Smith charts together with the answer booklet.

Question 1

An antenna operating at 1 GHz has an impedance of $(120 - j50)\ \Omega$ and is fed by a 50 Ω air-filled coaxial cable.

(a) Without using Smith chart, determine the following.

(i) The voltage reflection coefficient at the antenna.

[3 marks]

(ii) The standing wave ratio on the coaxial cable.

[3 marks]

(iii) The input impedance of the coaxial cable if it has a length of 1 m.

[4 marks]

(b) With the aid of Smith charts provided at the end of this question paper, design a single stub tuner to match the antenna to the coaxial cable, using a 50 Ω shunt short-circuited stub, by finding

(i) the shortest electrical distance between the stub and the antenna and

[8 marks]

(ii) the stub electrical length.

[7 marks]

(**You need to submit the worked Smith charts.** Write all markings and labels clearly. Detach them from the question paper and tie them to your answer booklet.)

Continued ...

Question 2

(a) Write down the four Maxwell equations in integral form and the associated physical laws.

[6 marks]

(b) By using Ampere's Law, $\nabla \times H = J$, modify it to become compatible for time-varying case.

[6 Marks]

(c) A circular loop of conducting wire of radius, r = 10 cm is placed in a uniform magnetic field, as shown in Fig. Q2. The magnetic field makes an angle of 30° with the loop's normal direction. The magnetic flux density, $\boldsymbol{B}$ is increased at a constant rate from $\boldsymbol{B_1}$ = 1 Tesla to $\boldsymbol{B_2}$ = 2 Tesla in a time interval Δt = 1 s.

(i) Find the electromotive force (emf) induced in the loop.

[11 marks]

(ii) Given the electrical resistance of the loop, R = 1Ω, find the current induced in the loop.

[2 marks]

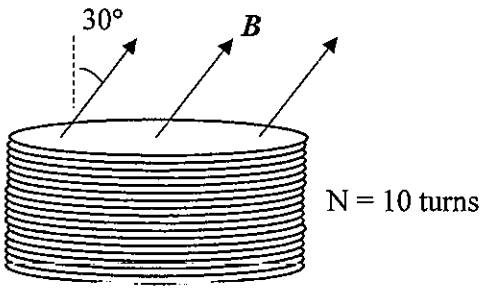

Fig. Q2

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Question 3

The electric field phasor of a uniform plane wave propagating through a lossless, nonmagnetic medium is given by

$$\tilde{\mathbf{E}} = \hat{\mathbf{x}} 20 e^{j0.6y} (V/m)$$

(a) If the relative permittivity of the medium, $\varepsilon_{r1} = 2.5$, determine the following:

(i) The direction of wave propagation.

[1 mark]

(ii) The phase velocity of the wave.

[2 marks]

(iii) The wavelength of the wave.

[2 marks]

(iv) The magnetic field phasor, $\tilde{\mathbf{H}}$.

[5 marks]

(v) The instantaneous expression for the electric field, $\mathbf{E}(y,t)$.

[3 marks]

(b) The wave is normally incident upon a second medium with relative permittivity, $\varepsilon_{r2} = 36$. Determine

(i) the reflected electric field phasor, $\tilde{\mathbf{E}}^r$ and

[6 marks]

(ii) the transmitted electric field phasor, $\tilde{\mathbf{E}}^t$.

[6 marks]

Continued ...

Question 4

(a) Explain why single conductor hollow waveguide does not support transverse electromagnetic (TEM) wave.

[5 marks]

(b) An oil-filled (dielectric constant = 2) waveguide has dimensions 3 cm × 4 cm. Determine the following.

(i) The dominant mode cutoff frequency.

[4 marks]

(ii) The range of frequencies for single mode operation.

[4 marks]

(c) An air-filled rectangular waveguide of dimensions a (m) × b (m) has a field component

$$H_z = 4\cos\left(\frac{2\pi y}{b}\right)\cos\left(4\pi\times10^9 t - 36z\right) \text{ mA/m}$$

Determine the following:

(i) The propagation mode.

[2 marks]

(ii) The operating frequency.

[1 mark]

(iii) The phase constant.

[1 mark]

(iv) The unbounded phase constant.

[2 marks]

(v) The cutoff frequency.

[3 marks]

(vi) The wave impedance.

[3 marks]

Common constants for air

Speed of light, c =	3×10^8 m/s
Permittivity, ε_0 =	8.854×10^{-12} F/m
Permeability, μ_0 =	$4\pi \times 10^{-7}$ H/m
Intrinsic impedance, η_0 =	377 Ω

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The Complete Smith Chart

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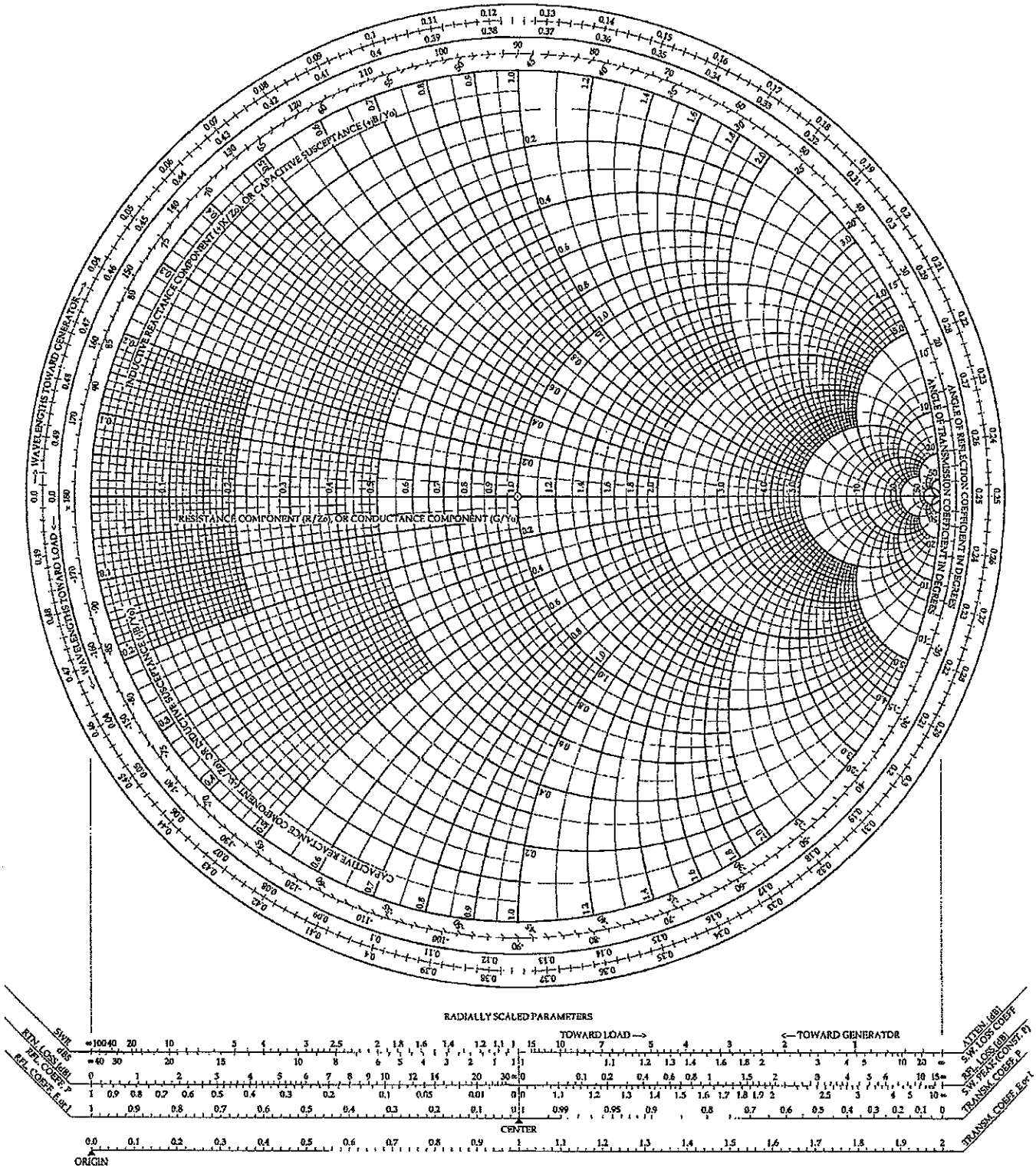
RESISTANCE COMPONENT (R/Zo), OR CONDUCTANCE COMPONENT (G/Yo)
INDUCTIVE REACTANCE COMPONENT (jX/Zo), OR CAPACITIVE SUSCEPTANCE (jB/Yo)
CAPACITIVE REACTANCE COMPONENT (-jX/Zo), OR INDUCTIVE SUSCEPTANCE (-jB/Yo)
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
ANGLE OF TRANSMISSION COEFFICIENT IN DEGREES
WAVELENGTHS TOWARD GENERATOR
WAVELENGTHS TOWARD LOAD
RADIALLY SCALED PARAMETERS
TOWARD LOAD —>
<— TOWARD GENERATOR
CENTER
ORIGIN

http://www.sss-mag.com/pdf/smithchart.pdf

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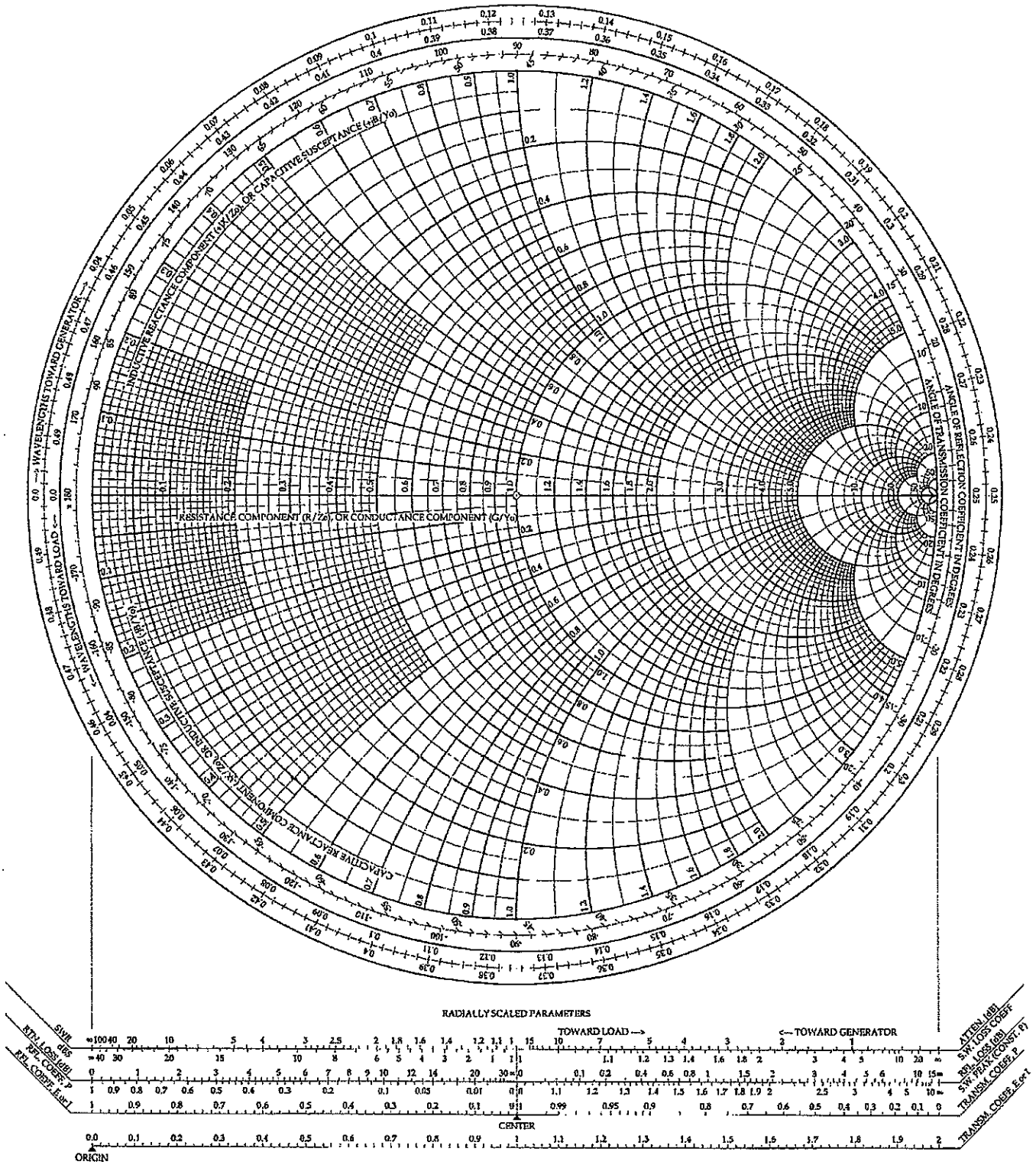
The Complete Smith Chart

Black Magic Design



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The Complete Smith Chart

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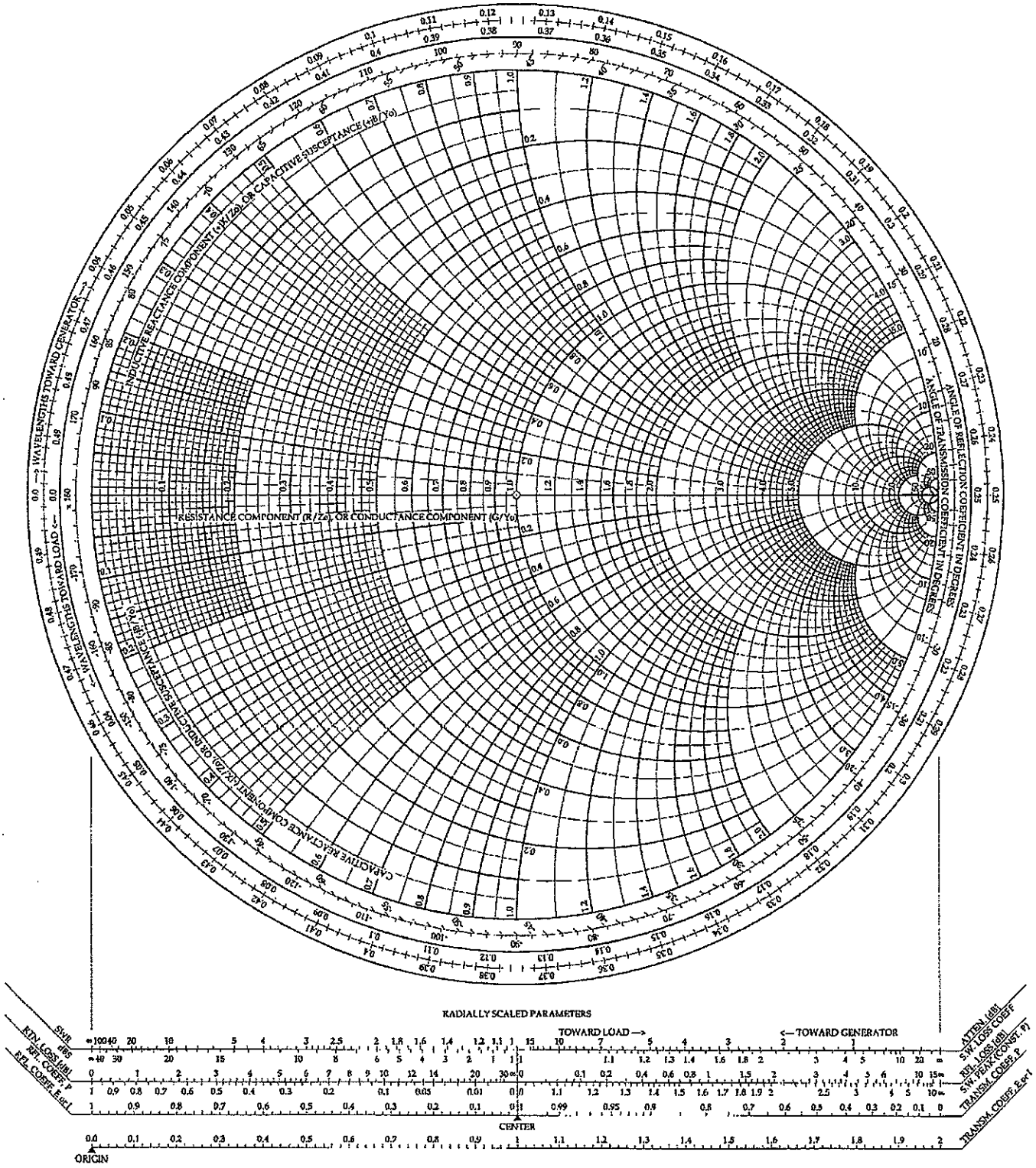

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The Complete Smith Chart

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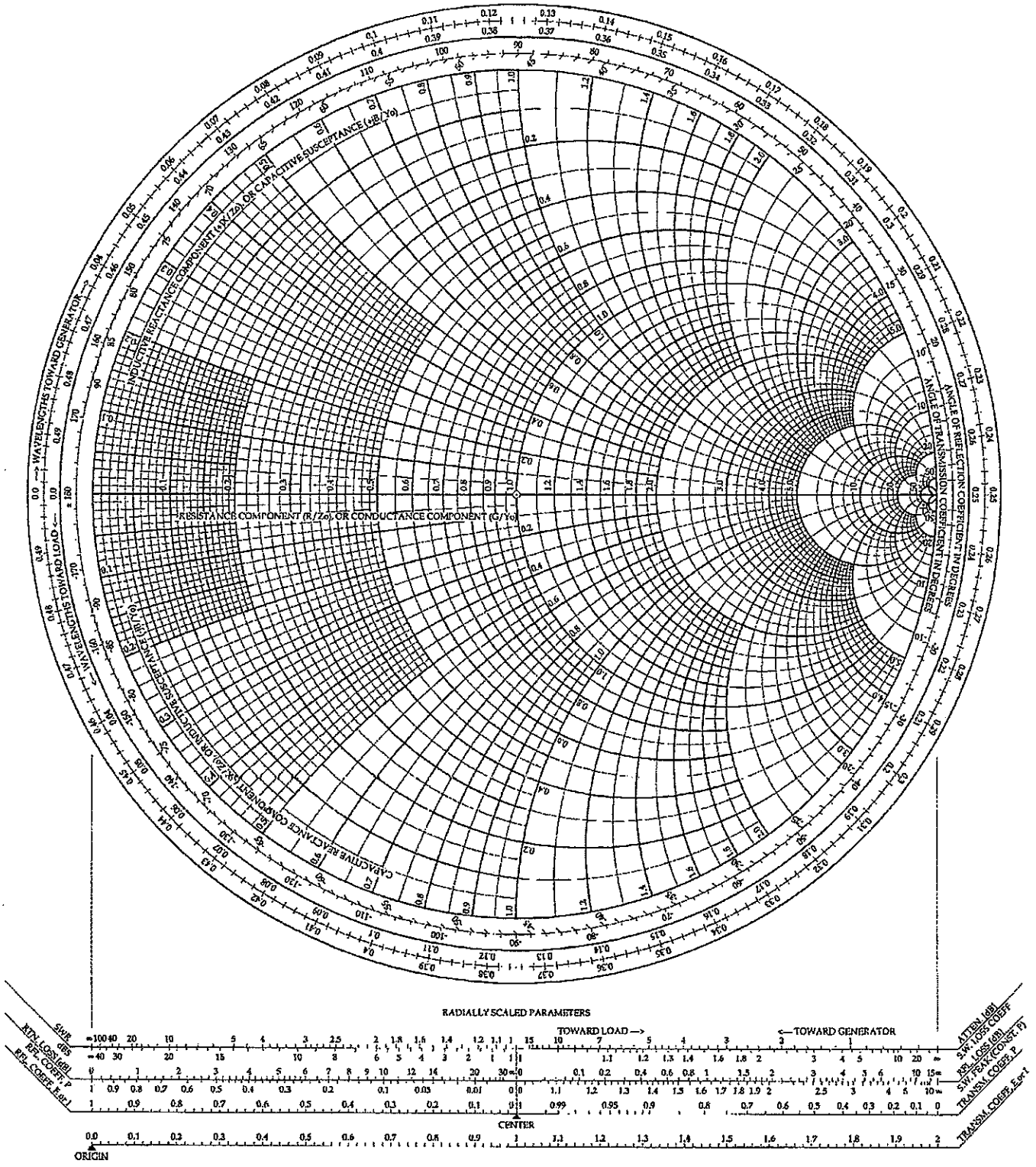

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